

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No. : 10/518,597 Confirmation No. 2632
Applicant : Laslaz et al.
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TC/A.U. : 1742
Title: : PART CAST FROM ALUMINUM ALLOY WITH HIGH HOT
STRENGTH
Examiner : Morillo, Janell Combs
Docket No. : A242 1090.US
Customer No. : 59554

Commissioner for Patents
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DECLARATION UNDER 37 CFR §1.132

I, Michel Garat, do hereby declare and say as follows:

1. I graduated from Engineers School "Ecole Supérieure de Physique et Chimie Industrielle" (ESPCI) (Paris) in 1973 with an engineering degree and a DEA in Macromolecular Materials. Since 1973, I have worked in the aluminum industry as R&D Engineer, then Development Manager, R&D Vice President from 2001 to 2005, and "Project Manager R&D-Foundry Alloys" till today, and I have been with Alcan (formerly Pechiney) working in their R&D Foundry alloy business since 1974. As a Project Manager since January 1, 2007, at R&D Foundry Alloys, I am responsible for the foundry research projects carried out in Alcan's Voreppe Research Center and for the technical relationship and alloy development with Alcan's foundry clients. Research relating to the development of improved heat resistant alloys for turbo-diesel cylinder heads is still one of our main topics as automotive applications are our main development field.

2. I have reviewed and am familiar with the contents of the above-referenced patent application ("the present application") of which I am a co-inventor, including the contents of FR 2690927 discussed in the Office Action dated December 6, 2006.
3. With regard to the creep resistance testing performed as reported in the specification of the present application, it is common to measure creep resistance by imposing a constant stress between 250-300°C and to monitor the progressive deformation which occurs over a set period of time, such for one hour or even up to periods extending for several hundreds of hours. This deformation is quantified by the % elongation of the test-piece. The lower the elongation (i.e. deformation), the higher the elevated temperature creep resistance of the alloy. This is explained, for example, in paragraphs [0033] and [0034] of the present application. On the contrary, in the conventional tensile test, in which a test-piece undergoes a rapidly increasing load until it breaks and the deformation is plotted against load, the elongation % is the basic way to characterize the ductility and is a positive property. It is especially difficult to achieve satisfactory creep resistance at hot temperatures (250-300°C) without negatively impacting ductility.
4. One advantage of the invention of the present application is that the mechanical strength and creep resistance of cast parts made of AlSiCuMg type alloys within the temperature range of 250-300°C are improved, without degrading their ductility, while avoiding an increased use of Nickel or addition of Vanadium that can cause problems in recycling or cause pollution.

5. The present invention differs in composition compared to those described in FR '927 as shown in Table 1 below:

Table 1. Composition Comparison

Element	Present Application	FR '927
Si	5-11	4-23
Fe	<0.6	-
Mg	0.15-0.6	0.1-1
Cu	0.3-1.5	0.3-4.5
Ti	0.05-0.25	0.1-0.2
Zr	0.05-0.25	0.1-0.2
Mn	<0.4	-
Zn	<0.3	-
Ni	<0.4	0.2-3
Other Elements	<0.1 each and 0.30 total, remainder Aluminum	Vanadium: 0.2-0.4

6. The alloys of the present application have a much narrower range of composition of Copper, Magnesium and Silicon as compared to the alloys described in FR'927. The present application also includes less than 0.1% of each element other than those specifically indicated above and hence Vanadium, if present at all, will be present in an amount less than 0.1%. By comparison, the alloys described in FR'927 require the addition of Vanadium, Zirconium and Titanium all at the same time. This need for a simultaneous addition of these three elements is described on page 5, lines 6 to 12 of FR '927 where the creep resistance obtained is explained to be much higher as compared to alloys containing only one or two of these elements.

7. In the invention of the present application, Vanadium falls under the category of “other elements” because its presence should be limited to very low levels (i.e. <0.1% which is approximately the impurity level). If Vanadium is added (i.e. in amounts of >0.1%), the Vanadium may not only increase cost and hinder recycling efforts, but may reduce the elongation ductility of the alloy.

8. Tests were conducted under my supervision and control to evaluate the hot creep resistance and high temperature ductility of alloys as described in the present application. The deformation data for two tested alloys (B and C) is summarized in Table 2, while the ductile elongation of two tested alloys (B and C) and Example 4 of FR ‘927 are summarized in Table 3.

Table 2. Deformation Summary

Temperature (°C)	250	250	300
Stress (MPa)	45	40	22
<u>Alloy B</u> Deformation (%) After 100 hrs	2.43	0.143	0.136
<u>Alloy C</u> Deformation (%) After 100 hrs	0.609	0.079	0.084
Reduction in Deformation (%)	~ 75%	~ 45%	~ 40%

Table 3. Ductile Elongation

	Elongation % (Ductility)	Elongation % (Ductility)
Temperature	250	300
Alloy B	34.5	34.6
Alloy C	34.5	35.0
FR '927 Example 4	19%	-

9. As summarized in Table 2 above, a reduction of 40% to 75% of the deformation by creep at 250°C and 300°C, respectively, was found upon the addition of Zirconium alone (i.e. no simultaneous addition of Vanadium along with Zirconium and Titanium as taught by FR '927). Moreover, this reduction was accomplished without reducing the ductile elongation which remained at a level of approximately 35% at both 250°C and 300°C for Alloy C as compared to only 19% in Example 4 of FR '927 (See Table 3 above; See also page 7 of FR '927 specification).
10. The addition of alloying elements such as Vanadium can cause a significant reduction in ductile elongation. It is my opinion that the addition of Vanadium at the levels of 0.2-0.4% as described in FR'927, was the reason for a marked reduction in ductile elongation at 300°C (i.e. from 24% in the base alloy to 19% in Example 4). Surprisingly and unexpectedly, alloys of the present invention maintained a high ductile elongation with little or no Vanadium (See Table 3 above and Table 1 of present specification).
11. In my opinion, the improved creep resistance and maintained high ductile elongation without the addition of Vanadium as demonstrated in the present specification is an unexpected behavior in light of the teachings of the prior art and in view of FR '927. Furthermore, the ability of alloys of the present application to exhibit improved deformation upon the addition of only Zirconium while maintaining ductile elongation is both unexpected in light of the teachings of FR '927 and advantageous.

As noted above, an alloy with little or no Vanadium content is advantageous because Vanadium is both extremely expensive and unfavorable with regard to recycling and pollution. This behavior is further unexpected in light of the present use of hypoeutectic alloys of the AlSi5-11Mg0.15-0.6 + Cu 0.3 – 1.5% type, and more specifically in the case of Example 1 (alloys B & C) of the A356 + Cu 0.5% type which is normally a rather soft alloy with a moderate creep strength.

12. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Michel Garat, Engineer.

Date: ____ April, 2007